



P/N 102360-001

# National Semiconductor Operations Guide

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## I. Battery Information and Trouble Shooting Tips

Although not many of our calculators come back, more than 20% of those returned to us for repair are not really defective at all. Most of these unnecessary returns could have been prevented simply by replacing the battery or by carefully re-reading the instruction manual. To make sure you aren't deprived of your calculator's use unnecessarily, please check the following points before sending it in:

- Turn your calculator on with the switch located on the left side of the calculator. The calculator is automatically cleared and the display should now show 0.
- If it does not, check to be sure the battery is still good. Batteries which are nearly dead can light the display to full intensity and yet cause entry or calculation errors. We suggest the use of an alkaline battery for longest life.
- Are the battery connectors making good contact? If these are slightly loose they can cause your calculator to malfunction intermittently. Try tightening loose connectors by bending inward slightly.
- Have you plugged in an AC adaptor with your calculator turned on? This can prevent you from being able to clear your machine. Simply turn it off for ten seconds or so and then back on.
- Many calculators display meaningless numbers when first turned on. This is normal. Simply press **C!** before beginning calculations.

### A. AC Adaptor

You can use your calculator on regular AC (mains) current by connecting the AC adaptor to the jack at the top of the machine. **BE SURE YOUR CALCULATOR IS TURNED OFF BEFORE CONNECTING THE ADAPTOR.**

### B. Low Battery Power

The calculator will show a decimal point on the extreme left hand side of the display as a low-battery indicator. Although calculations can still be made while the low-battery indicator is on, the battery should be replaced as soon as possible. Continued use on a weak battery may result in inaccurate answers.

### C. Battery Installation

Your calculator is powered by a 9-volt alkaline battery which should give you about 10 hours of continuous operation. To change the battery, turn the machine over, place a small coin in the little slot at the top of the battery door and gently pull toward you. The battery door will slip out. **BE SURE THE CALCULATOR IS TURNED OFF BEFORE REPLACING THE BATTERY OR CONNECTING IT TO THE AC ADAPTOR.** Then slip the bottom of the battery door in place and, squeezing **GENTLY** on the two prongs on the door, snap it back in place.

### D. Automatic Display Shutoff

To save the battery life, the calculator automatically shuts off the display and shows all decimal points if no key has been pressed for approximately 35 seconds. No data has been changed and further entries or operations will bring back the display. To restore the display without changing its contents, press the **CHS** key twice.

## II. Service

We hope you find these suggestions helpful. If you ever do need service, pack your machine safely and send it insured—with payment enclosed—to one of the addresses listed on page 28. Repair prices are listed in the Warranty of this instruction book on page 27.

### III. Accuracy Limitations

The maximum number of digits which your calculator can display and use for internal calculations is eight. During the calculation of log and trig functions,  $Y^x$  and square root intermediate answers are generated internally, which often exceed the eight-digit capacity. Truncation of excess digits occurs during these calculations, and accuracy is affected.

Examples:

#### A. Trigonometric Functions: small and large angles

1.  $\sin 185^\circ = -0.08715574275$  carried out to 12 digits.

Calculator displays:  $-.0871555$

2.  $\cos 0.05^\circ = 0.9999996192$  carried out to 12 digits.

Calculator displays:  $.9999997$

#### B. Antilog Functions:

1.  $e^{-28} = 6.914400107 \times 10^{-13}$

Calculator displays: 0. (Explanation: answer too small to be displayed.)

2.  $e^{18} = 65659969.14$

Calculator displays:  $65659930.$

#### C. $Y^x$ Function:

Raising numbers to powers using the  $Y^x$  key is computed internally using a log/antilog conversion routine. This, in combination with ninth-digit truncation, results in obvious inaccuracies. You should round off these answers at the fifth-digit position from the left.

1.  $5^3 = 125$

Calculator displays:  $124.9999$

2.  $2^3 = 8$

Calculator displays:  $7.999994$

3.  $4.5^{0.2} = 1.350960039$

Calculator displays:  $1.350959$

4.  $5^{10} = 9765625$

Calculator displays:  $9765621.$

### IV. Exceeding 8-Digit Capacity Display Shows: .0.0.0.0.0.0.0.0.

Performing an operation that results in a final or internally computed intermediate answer which is too large (greater than eight digits, 99999999) causes error indication .0.0.0.0.0.0.0.0. The chart below lists these conditions:

| FUNCTION                      | CONDITION                             |
|-------------------------------|---------------------------------------|
| $+, -, \times, \div$          | Result exceeds 99999999               |
| $\div, 1/x$                   | Divisor equal to 0, or .00000001      |
| $\sqrt{\quad}$                | Negative radicand                     |
| $Y^x$                         | $Y \leq 0$ ; result exceeds 99999999. |
| $\log x, \ln x$               | $X \leq 0$                            |
| $e^x$                         | $18.42068 < x < -28.$                 |
| $\sin x, \cos x,$<br>$\tan x$ | $x \geq 401^\circ$                    |
| $\sin^{-1} x, \cos^{-1} x$    | $ x  > 1$                             |

### V. Reverse Polish Logic and The Stack Principle

Your calculator uses Reverse Polish logic with three registers called X, Y and Z. A register is an electronic element used to store data while it is being displayed, processed or waiting to be processed. The three registers are arranged in a "stack" as follows: (To avoid confusion between the name of a register and its contents, the registers in this diagram are represented by capital letters X, Y and Z and the contents of the registers by lower case letters x, y and z).



| CONTENTS | LOCATION |
|----------|----------|
| z        | Z        |
| y        | Y        |
| x        | X        |

The display always shows the contents (x) of register X. See Stack Diagrams which show what happens to the stack for each operation of the calculator.

## VI. Keying In and Entering Numbers

If your number includes a decimal point, key it in with the number. If a decimal is keyed in more than once in a number entry, the calculator will use the last decimal keyed in. You do not have to key in the decimal in whole numbers. To enter a negative number, key in the number and touch **CHS**.

### A. Correcting Wrong Entries

To clear a wrong number entry, touch **C↓**. Touching **C↓** clears the X register (display) and drops the stack down. Touching **F** accesses double function keys. If **F** is touched accidentally, touch **C↓** to cancel the effect. The stack is not affected.

### B. Memory Clear

To clear memory, key in: 0 **MS**.

## VII. Keyboard Explanation

### A. One-Factor Calculation Keys

One-factor functions work directly on the number in the display. There is no need to touch **ENT** before performing the function. These keys are listed and explained below:

**F** Accesses lower functions on these keys:  
 $(\sin^{-1})$   $(\cos^{-1})$   $(\tan^{-1})$   $(x^2)$   $(M+x^2)$   
 $(\text{rad})$   $(\text{deg})$   $(M+)$   $(M-)$

**sin** Upper function: Computes the sine of the angle in the display.

$(\sin^{-1})$  Lower function: Computes the inverse sine (arc sine) of the number in the display.

*Example:* What is the sine of  $30^\circ$ ?

Key in: 30 **sin**;

Display shows: .5

*Example:* What is the arc sine of .5?

With .5 in display from previous example:

Key in: **F**  $(\sin^{-1})$ ;

Display shows: 30

**cos** Upper function: Computes the cosine of the angle in the display.

$(\cos^{-1})$  Lower function: Computes the inverse cosine (arc cosine) of the number in the display.

**tan** Upper function: Computes the tangent of the angle in the display.

$(\tan^{-1})$  Lower function: Computes the inverse tangent (arc tangent) of the number in the display.

**e<sup>x</sup>** Computes the natural antilogarithm of the number in display (raises e to "x" power).

*Example:* Compute  $e^2$

Key in: 2 **e<sup>x</sup>**;

Display shows: 7.389051

**ln** Computes the natural logarithm of the number in the display.

*Example:* Compute the natural logarithm of 3.5

Key in: 3.5 **ln**;

Display shows: 1.252763

**1/x** Computes the reciprocal of the number in the display (divides 1 by "x").

*Example:* Find the reciprocal of 5

Key in: 5 **1/x**;

Display shows: .2

- $\pi$  Enters Pi ( $\pi$ ) into the display.
- $\sqrt{\phantom{x}}$  Upper function: Computes the square root of the number in the display.
- $(x^2)$  Lower function: Squares the number in the display.

*Example:* What is the square root of 144?

Key in: 144  $\sqrt{\phantom{x}}$ ;  
Display shows: 12.

*Example:* What is 5 squared?

Key in: 5  $F (x^2)$ ;  
Display shows: 25.

- $\log$  Computes the common logarithm of the number in the display.
- $x \leftrightarrow y$  Exchanges the number now in the display with the number previously in the display.
- MR Recalls the contents of memory to the display.
- MS Upper function: Stores the number in the display in memory.
- $(M+x^2)$  Lower function: Adds the square of number in the display to the contents of memory.
- CHS Changes the sign of number in the display.

## B. Two-Factor Calculation Keys

To enter the first number in a 2-factor calculation, key in number and touch  $\text{ENT}$ . To enter a negative number, key in number and touch  $\text{CHS}$ , then  $\text{ENT}$ .

- $\text{ENT}$  Enters the number in the display into a working register ("y").
  - $\div$  Upper function: Divides "y" by "x".
  - $(\text{rad})$  Lower function: Converts the number of degrees in the display to radians.
- Example:* Key in: 36  $\text{ENT}$  12  $\div$ ;  
Display shows: 3.

*Example:* How many radians is  $30^\circ$ ?  
Key in: 30  $F (\text{rad})$ ;  
Display shows: .52359877

- $\times$  Upper function: Multiplies "y" by "x".
- $(\text{deg})$  Lower function: Converts the number of radians in the display to degrees.

*Example:* Key in: 15  $\text{ENT}$  3  $\times$ ;  
Display shows: 45.

*Example:* What is the sine of .6 radians?  
Key in: .6  $F (\text{deg}) \sin$ ;  
Display shows: .5646425

- $-$  Upper function: Subtracts "x" from "y".
- $(M-)$  Lower function: Subtracts the number in the display from the contents of memory.
- $+$  Upper function: Adds "x" to "y".
- $(M+)$  Lower function: Adds the number in the display to the contents of memory.

*Example:* Key in: 5  $\text{ENT}$  3  $+$ ;  
Display shows: 8.

$Y^x$  Raises "y" to the "x" power.  
*Example:* Key in: 5  $\text{ENT}$  3  $Y^x$ ;  
Display shows: 124.9999\*

Since taking the  $x^{\text{th}}$  root of y is the same as raising y to the  $1/x$  power, roots are obtained by touching  $1/x$  before touching  $Y^x$ .

*Example:* Key in: 125  $\text{ENT}$  3  $1/x Y^x$ ;  
Display shows: 4.999995\*

\*See Accuracy Limitations

## VIII. Summary: Memory Operations

- MS Stores the number in the display in memory (register M).
- MR Recalls the contents of memory (register M) to the display (register X).



## Memory Clear

To clear memory, key in: 0 **MS**.

## Accumulating Memory

- (M+) Touched after **F**, adds contents of display to contents of memory. Display (register X) is unaffected.
- (M-) Touched after **F**, subtracts contents of display from contents of memory. Display (register X) is unaffected.
- (M+x<sup>2</sup>) Touched after **F**, adds square of contents of display to contents of memory. Display (register X) is unaffected.

Example: Compute the following:  $\Sigma x = 1 + 2 + 3 = 6$ ;  
 $\Sigma x^2 = 1^2 + 2^2 + 3^2 = 14$ .

| KEY IN                       | DISPLAY SHOWS | COMMENTS  |
|------------------------------|---------------|---|
| 0 <b>MS</b>                  | 0.            | Clear memory.   |
| 1                            | 1             |   |
| <b>F</b> (M+x <sup>2</sup> ) | 1.            | x <sup>2</sup> summed in memory.                            |
| 2                            | 2             |   |
| <b>F</b> (M+x <sup>2</sup> ) | 2.            | 1 <sup>2</sup> + 2 <sup>2</sup> in memory.                  |
| <b>+</b>                     | 3.            | 1 + 2 in register X.  |
| 3                            | 3             |   |
| <b>F</b> (M+x <sup>2</sup> ) | 3.            | 1 <sup>2</sup> + 2 <sup>2</sup> + 3 <sup>2</sup> in memory. |
| <b>+</b>                     | 6.            | 1 + 2 + 3 in register X.                                    |
| <b>MR</b>                    | 14.           | Recall x <sup>2</sup> .                                     |

Example: Using memory to store a constant, compute the following:

- 5 x 1.23456 = ?  
 16 x 1.23456 = ?  
 40 x 1.23456 = ?

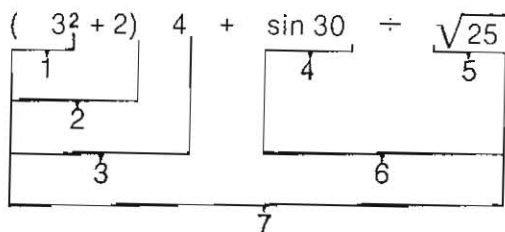
| KEY IN    | DISPLAY SHOWS | COMMENTS                  |
|-----------|---------------|---------------------------|
| 1.23456   | 1.23456       |                           |
| <b>MS</b> | 1.23456       | Store constant in memory. |
| 5         | 5.            | 1st variable.             |
| <b>X</b>  | 6.1728        | Answer 1.                 |
| <b>MR</b> | 1.23456       | Recall constant.          |
| 16        | 16.           | 2nd variable.             |
| <b>X</b>  | 19.75296      | Answer 2.                 |
| <b>MR</b> | 1.23456       | Recall constant.          |
| 40        | 40            | 3rd variable.             |
| <b>X</b>  | 49.3824       | Answer 3.                 |

## IX. Mathematical Hierarchy and Reverse Polish Logic

"Hierarchy" is a term for the rules of mathematics which tell you in which order to perform operations on numbers. Those rules are:

1. Try to do the problem left to right (this may not always be possible).
2. Do all operations within parentheses, if any, first.
3. Perform operations in the following order:
  - a. raising to powers, taking roots, trig, log and reciprocal functions.
  - b. multiplication and subtraction.
4. Repeat steps 1 through 3 until the calculation is complete.

Example: The equation  $(3^2 + 2)4 + \sin 30 / \sqrt{25}$  = 44.1 is solved according to the rules of hierarchy as follows:



1.  $3^2 = 9$ .
2.  $9 + 2 = 11$ .
3.  $11 \times 4 = 44$ .
4.  $\sin 30 = .5$ .
5.  $\sqrt{25} = 5$ .
6.  $.5 \div 5 = .1$ .
7.  $44 \div .1 = 44.1$ .

If you remember the following three steps in applying Reverse Polish logic to the rules of hierarchy, you will quickly master your calculator and have confidence in its answers.

1. Starting at the left and working right, key in the next number (or the first if this is the beginning of a new problem).
2. Ask yourself: "Can an operation be performed according to the rules of hierarchy?" If so, perform all operations possible. If not, touch **ENT**.
3. Repeat steps 1 and 2 until your calculation is complete.

**Example:** Following these three steps, you can calculate the equation  $(3^2 + 2)4 + \sin 30 / \sqrt{25}$  using Reverse Polish logic as follows:

| KEY IN             | DISPLAY SHOWS | COMMENTS       |
|--------------------|---------------|----------------|
| 3                  | 3             |                |
| <b>F</b> ( $x^2$ ) | 9.            | $3^2$ .        |
| 2                  | 2             |                |
| <b>+</b>           | 11.           | $3^2 + 2$ .    |
| 4                  | 4             |                |
| <b>X</b>           | 44.           | $(3^2 + 2)4$ . |
| 30                 | 30            |                |

|            |      |                                      |
|------------|------|--------------------------------------|
| <b>sin</b> | .5   | $\sin 30$ .                          |
| 25         | 25.  |                                      |
| <b>√</b>   | 5.   | $\sqrt{25}$ .                        |
| <b>÷</b>   | .1   | $\sin 30 / \sqrt{25}$ .              |
| <b>+</b>   | 44.1 | $(3^2 + 2)4 + \sin 30 / \sqrt{25}$ . |

Calculation is complete and performed according to the rules of hierarchy.

## X. Chain Calculations

The number in the display is always ready to have calculations performed on it.

**Example:**  $(2 + 3) \times (4 + 5) = 45$ .

| KEY IN     | DISPLAY SHOWS |
|------------|---------------|
| 2          | 2             |
| <b>ENT</b> | 2.            |
| 3          | 3             |
| <b>+</b>   | 5.            |
| 4          | 4             |
| <b>ENT</b> | 4.            |
| 5          | 5             |
| <b>+</b>   | 9.            |
| <b>X</b>   | 45.           |

## XI. Stack Diagrams

The following diagrams show what happens to the stack for each operation of your calculator.

Contents of registers are indicated by lower-case letters x, y and z. Locations are indicated by capital letters X, Y and Z. The display always shows the contents of register X. Memory is register M.



| TOUCH | CONTENTS | LOCATION            |
|-------|----------|---------------------|
| ENT   |          | LOST<br>Z<br>Y<br>X |

| TOUCH | CONTENTS | LOCATION                 |
|-------|----------|--------------------------|
| MS    |          | Z<br>Y<br>X<br>M<br>LOST |

| TOUCH | CONTENTS | LOCATION            |
|-------|----------|---------------------|
| C↓    |          | Z<br>Y<br>X<br>LOST |

| TOUCH   | CONTENTS | LOCATION         |
|---------|----------|------------------|
| F<br>C↓ |          | Z<br>Y<br>X<br>M |

| TOUCH                                    | CONTENTS | LOCATION            |
|--|----------|---------------------|
| 0 1<br>2 ... 9<br>AFTER TOUCHING<br>ENT↑ |          | LOST<br>Z<br>Y<br>X |

| TOUCH   | CONTENTS | LOCATION            |
|---|----------|---------------------|
| 0 1<br>2 ... 9<br>AFTER TOUCHING<br>ANY FUNCTION<br>KEY |          | LOST<br>Z<br>Y<br>X |

| TOUCH | CONTENTS   | LOCATION            |
|-------|--|---------------------|
| $\pi$ | $z \rightarrow$<br>$y \rightarrow$<br>$x \rightarrow$<br>$\pi \rightarrow$ | LOST<br>Z<br>Y<br>X |

| TOUCH | CONTENTS   | LOCATION                 |
|-------|--|--------------------------|
| MR    | $z \rightarrow$<br>$y \rightarrow$<br>$x \rightarrow$<br>$m \rightarrow$ | LOST<br>Z<br>Y<br>X<br>M |

| TOUCH | CONTENTS | LOCATION |
|-------|----------|----------|
| SIN   | 0        | LOST     |
| COS   | z        | Z        |
| TAN   | y        | Y        |
| ln    | x        | X        |
| LOG   | f(x)     | LOST     |
| $e^x$ |          |          |

| TOUCH | CONTENTS   | LOCATION            |
|-------|--|---------------------|
| $Y^x$ | $0 \rightarrow$<br>$z \rightarrow$<br>$y \rightarrow$<br>$x \rightarrow$ | LOST<br>Z<br>Y<br>X |

\*Note: Performing any trig, log or antilog function clears register Z.  $f(x)$  is transferred to register X, and register Y remains unchanged. Performing the  $Y^x$  function clears register Z. The contents of register X are transferred to register Y and  $Y^x$  are transferred to register X.

| TOUCH           | CONTENTS | LOCATION |
|-----------------|----------|----------|
| F               | 0        | LOST     |
| ( $\sin^{-1}$ ) | z        | Z        |
| or              | y        | Y        |
| ( $\cos^{-1}$ ) | x        | X        |
| or              | f(x)     | LOST     |
| ( $\tan^{-1}$ ) |          |          |



| TOUCH                         | CONTENTS  | LOCATION |
|-------------------------------|---|----------|
| $1/x$<br>$\sqrt{\phantom{x}}$ | $z \longrightarrow Z$<br>$y \longrightarrow Y$<br>$x \longrightarrow X$<br>$f(x) \longrightarrow \text{LOST}$ |          |

| TOUCH                                     | CONTENTS  | LOCATION |
|---|---|----------|
| <div>F</div> <div>(M+X<sup>2</sup>)</div> | <div>z → Z</div> <div>y → Y</div> <div>x → X</div> <div>m → M</div> <div>M+X<sup>2</sup> → LOST</div> |          |

| TOUCH                                   | CONTENTS   | LOCATION |
|---|--|----------|
| <div>F</div> <div>(X<sup>2</sup>)</div> | <div>z → Z</div> <div>y → Y</div> <div>x → X</div> <div>x<sup>2</sup> → LOST</div> |          |

| TOUCH                 | CONTENTS  | LOCATION |
|-----------------------|---|----------|
| $X \leftrightarrow Y$ | $z \longrightarrow Z$<br>$y \longrightarrow Y$<br>$x \longrightarrow X$ |          |

| TOUCH  | CONTENTS   | LOCATION |
|--|--|----------|
| <div>F</div> <div>(rad)</div> <div>or</div> <div>(deg)</div> | <div><math>z \longrightarrow Z</math></div> <div><math>y \longrightarrow Y</math></div> <div><math>x \longrightarrow X</math></div> <div><math>f(x) \longrightarrow \text{LOST}</math></div> <div>(RADIANS TO DEGREES</div> <div>OR</div> <div>DEGREES TO RADIANS)</div> |          |

| TOUCH               | CONTENTS | LOCATION |
|---------------------|----------|----------|
| ERROR<br>INDICATION | 0        | LOST     |
|                     | z        | Z        |
|                     | y        | Y        |
|                     | x        | X        |
|                     | 0        | LOST     |
|                     | m        | M        |

| TOUCH    | CONTENTS | LOCATION             |
|----------|----------|----------------------|
| $+$      | 0        |                      |
| $-$      | z        | Z                    |
| $\times$ | y        | Y                    |
| $\div$   | x        | $f(x) \rightarrow X$ |

$f(x): y + x \rightarrow X$   
 $y - x \rightarrow X$   
 $y \times x \rightarrow X$   
 $y \div x \rightarrow X$

| TOUCH    | CONTENTS                    | LOCATION             |
|----------|-----------------------------|----------------------|
| <b>F</b> | z                           | Z                    |
| (M+)     | y                           | Y                    |
| (M-)     | x                           | X                    |
|          | m                           | $f(x) \rightarrow M$ |
|          |                             | LOST                 |
|          | $f(x): m + x \rightarrow M$ |                      |
|          | $m - x \rightarrow M$       |                      |

#### A. Sum of Products and Product of Sums

Sum of products:  $(2 \times 3) + (4 \times 5) = 26$

| KEY IN   | DISPLAY SHOWS |
|----------|---------------|
| 2        | 2             |
| ENT      | 2.            |
| 3        | 3             |
| $\times$ | 6.            |
| 4        | 4             |

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|          |     |
|----------|-----|
| ENT      | 4.  |
| 5        | 5   |
| $\times$ | 20. |
| $+$      | 26. |

Product of sums:  $(2 + 3) \times (4 + 5) = 45$

| KEY IN   | DISPLAY SHOWS |
|----------|---------------|
| 2        | 2             |
| ENT      | 2.            |
| 3        | 3             |
| $+$      | 5.            |
| 4        | 4             |
| ENT      | 4.            |
| 5        | 5             |
| $+$      | 9.            |
| $\times$ | 45.           |


#### B. Adding Time, or Degrees, Minutes and Seconds

Add 1 hour, 45 minutes and 45 seconds to 1 hour, 30 minutes and 20 seconds. Enter all times as hh.mmss where hh = hours, mm = minutes and ss = seconds (dd.mmss for degrees, minutes and seconds).

| KEY IN | DISPLAY SHOWS | COMMENTS  |
|--------|---------------|---|
| 1.4545 | 1.4545        | 1 hour, 45 min., 45 sec.  |
| ENT    | 1.4545        |   |
| 1.3020 | 1.3020        | 1 hour, 30 min., 20 sec.  |
| $+$    | 2.7565        | Now, look at the "ss" part of the answer (65). If it is above 60, * add .004. Repeat this step until the seconds portion of the answer is below 60. |

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.004      .004  
      2.7605      Now, look at the "mm" part of the answer (76). If it is above 60, \* add .4. Repeat as you did with the seconds portion.

.4      .4  
      3.1605      Final answer: 3 hours, 16 minutes, 5 seconds.

\*Note: Any actual sum of the minutes and seconds above 60 will be handled in this manner; i.e., 50 seconds plus 50 seconds will appear as 00 in the display, but think of the actual sum as 100.

### C. Degrees, Minutes and Seconds to Decimal Degrees Conversion

Example: Convert the following degrees, minutes and seconds to decimal degrees:  $56^{\circ}23'44.5''$

| KEY IN   | DISPLAY SHOWS | COMMENTS           |
|--|---------------|--------------------|
| 44.5   | 44.5          | Seconds.           |
|    | 44.5          |                    |
| 60   | 60            | 60 seconds/minute. |
|    | 60.           |                    |
|   | .74166666     |                    |
| 23   | 23            | Minutes.           |
|  | 23.741666     |                    |
|  | 60.           | 60 minutes/degree. |
|  | .39569443     |                    |
| 56   | 56            | Degrees.           |
|  | 56.395694     | Decimal degrees.   |












### D. Polar to Rectangular Coordinate Conversion


Example: Convert the coordinates  $\theta = 35^{\circ}$ ,  $R = 7$  to rectangular coordinates using the formulas:

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$$X = R \cos \theta,$$

$$Y = R \sin \theta.$$

| KEY IN  | DISPLAY SHOWS | COMMENTS                        |
|---|---------------|---------------------------------|
| 35  | 35            | $\theta$ .                      |
|  | 35.           |                                 |
| 7   | 7             | R.                              |
|  | 7             | Store R in register M.          |
|  | 35.           |                                 |
|  | 35.           | Store $\theta$ in register Y.   |
|  | 0.8191521     | $\cos \theta$ .                 |
|  | 7.            | Recall R.                       |
|  | 5.7340647     | X displayed = $R \cos \theta$ . |
|  | 35.           | $\theta$ .                      |
|  | 0.5735765     | $\sin \theta$ .                 |
|  | 7.            | Recall R.                       |
|  | 4.0150355     | Y displayed = $R \sin \theta$ . |




Note: To see X again, touch .

### E. Rectangular to Polar Coordinate Conversion

Example: Convert the coordinates  $X = 6$ ,  $Y = 8$  to polar coordinates R and  $\theta$ . Using the formula:

$$R = \sqrt{X^2 + Y^2}$$

$$\theta = \tan^{-1} Y/X.$$

| KEY IN  | DISPLAY SHOWS | COMMENTS  |
|---|---------------|---|
| 6   | 6             | X coordinate.   |
|  | 6.            |   |
|  | 6.            | Transfer contents of register Y to register Z to save for use in calculating $\theta$ . |
|  | 36.           |   |
| 8   | 8             | Y coordinate.   |

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|                        |           |  |
|------------------------|-----------|--|
| MS                     | 8.        | Save for use in calculating $\theta$ .             |
| F (x <sup>2</sup> )    | 64.       |  |
| +                      | 100.      | X <sup>2</sup> + Y <sup>2</sup>                    |
| $\sqrt{\phantom{x}}$   | 10.       | R calculated.                                      |
| x-y                    | 6.        | Exchange to bring X coordinate back to register X. |
| MR                     | 8.        | Recall Y coordinate.                               |
| x-y                    | 6.        | Exchange to divide Y by X.                         |
| $\div$                 | 1.3333333 |  |
| F (tan <sup>-1</sup> ) | 53.1301   | $\theta$ calculated.                               |

Note: To see R again, touch **x-y**.

#### F. Mean, Variance and Standard Deviation

**Example:** Find the mean, variance and standard deviation of the following values: (2, 7, 3, 5, 2).

Using the formulas:

$$\text{Mean} = \bar{x} = \frac{\sum x}{n}$$

$$\text{Variance} = \sigma^2 = \frac{\sum x^2 - n(\sum x/n)^2}{n-1}$$

$$\text{Standard Deviation} = \sigma = \sqrt{\sigma^2}$$

| KEY IN                | DISPLAY SHOWS | COMMENTS      |
|-----------------------|---------------|---------------|
| 0                     | 0             |               |
| MS                    | 0.            | Clear memory. |
| 2                     | 2             | x1.           |
| F (M+x <sup>2</sup> ) | 2.            |               |
| ENT                   | 2.            |               |
| 7                     | 7             | x2.           |
| F (M+x <sup>2</sup> ) | 7.            |               |
| +                     | 9.            |               |

|                       |           |                     |
|-----------------------|-----------|---------------------|
| 3                     | 3         | x3.                 |
| F (M+x <sup>2</sup> ) | 3.        |                     |
| +                     | 12.       |                     |
| 5                     | 5         | x4.                 |
| F (M+x <sup>2</sup> ) | 5.        |                     |
| +                     | 17.       |                     |
| 2                     | 2         | x5.                 |
| F (M+x <sup>2</sup> ) | 2.        |                     |
| +                     | 19.       |                     |
| 5                     | 5         | n                   |
| $\div$                | 3.8       | Mean (x).           |
| F (x <sup>2</sup> )   | 14.44     |                     |
| CHS                   | -14.44    |                     |
| 5                     | 5         | n                   |
| $\times$              | -72.2     |                     |
| MR                    | 91        |                     |
| +                     | 18.8      |                     |
| 4                     | 4         | n-1                 |
| $\div$                | 4.7       | Variance.           |
| $\sqrt{\phantom{x}}$  | 2.1679483 | Standard deviation. |

Repeat these steps n-1 times.



## WARRANTY INFORMATION

The Consumer Products Division of National Semiconductor Corporation is proud to give you the following Warranty on your calculator.

### Full 90-Day Warranty

National Semiconductor gives you a full ninety-day Warranty from the date of original purchase on all defects in material and workmanship. Should the calculator prove to have such defects within ninety days of original purchase, National Semiconductor will repair, or, at its discretion, replace it with a new calculator, all without charge, within a reasonable period of time after receipt by National Semiconductor, postage prepaid. This FULL WARRANTY does not apply to defects or malfunctions caused by abuse, accident, modifications, negligence, or any other damage not resulting from defects in materials or workmanship or beyond the control of National Semiconductor. THIS FULL WARRANTY IS IN LIEU OF ANY CLAIM BY THE CONSUMER FOR CONSEQUENTIAL OR INCIDENTAL DAMAGES and shall apply to the purchaser or the purchaser's transferee, so long as mailing instructions below are followed.

### Limited 275-Day Warranty

National Semiconductor also offers a LIMITED WARRANTY in addition to the above FULL WARRANTY which shall apply to any defects in material or workmanship which occur during the 275-day period after the 90-day period covered by the FULL WARRANTY, excluding the battery, which is not a component part of your calculator. Under this LIMITED WARRANTY, National Semiconductor, for a service charge of U.S. \$3.50, and for no additional charge will repair such defects or, at its discretion, replace your calculator

with one that is identical or reasonably equivalent, all within a reasonable period of time after receipt by National Semiconductor, postage prepaid. This LIMITED WARRANTY does not apply to defects or malfunctions caused by abuse, accident, modifications, negligence, or any other damage not resulting from defects in materials or workmanship or beyond the control of National Semiconductor. THIS LIMITED WARRANTY IS IN LIEU OF ANY CLAIM BY THE CONSUMER FOR CONSEQUENTIAL OR INCIDENTAL DAMAGES and shall apply to the purchaser or the purchaser's transferee, so long as the mailing instructions below are followed. THE DURATION OF ALL IMPLIED WARRANTIES ON THIS CALCULATOR WILL BE THE SAME AS, AND NO LONGER THAN, THE 365-DAY PERIOD OF THE FULL AND LIMITED WARRANTIES COMBINED.

### Post Warranty Repairs

Even though your Warranty may have expired, if your calculator becomes defective after the 365-day warranty period, National Semiconductor will make repairs for a nominal charge of \$7.50, providing the mailing instructions below are followed. Repair prices during the post-warranty period are subject to change without notice.

## Product Service Locations

United States  
N.C.P.S.— East Coast  
Commerce Park  
Danbury, CT 06810

United States  
N.C.P.S.— Central U.S.  
P.O. Box 1000  
West Jordan, UT 84084

Canada  
N.S. Electronics  
286 Wildcat Road  
Downsview  
Ontario M3J-2N5  
Canada

Asia  
NS Electronics SDN BHD  
National Semiconductor  
Product Service  
Bayan Lepas  
Free Trade Zone  
Penang, Malaysia

Scotland  
NS—UK Ltd.  
National Semiconductor  
Product Service  
Larkfield Industrial Estate  
Greenock PA 16 OEQ,  
Scotland

Germany  
National Semiconductor GmbH  
Product Service  
D808 Furstenfeldbruck  
Industriestrasse 10  
Bundesrepublik  
Deutschland

## Consumer Warranty Registration Certificate

Please put your warranty into effect by completing this form and mailing it within 10 days from date of purchase to the National Semiconductor Service Center in your area.

Model 4510

Serial Number \_\_\_\_\_

Purchase Date \_\_\_\_\_  
(month/day/year)

Purchased from \_\_\_\_\_

Address \_\_\_\_\_

City, State, Zip \_\_\_\_\_

Your Name \_\_\_\_\_

Your Address \_\_\_\_\_

City, State, Zip \_\_\_\_\_

For further information see your dealer or write:

NATIONAL SEMICONDUCTOR  
CUSTOMER RELATIONS DEPT.  
1177 Kern Avenue  
Sunnyvale, CA 94086  
(408) 733-2600